Predictability of the simple technical trading rules

Predictability of the Simple Technical Trading Rules: An Out-of-Sample Test

Jiali Fang

Ben Jacobsen

Yafeng Qin

This version: 13/06/2012

Abstract

In a true out of sample test we find no evidence that several well-known technical trading strategies predict stock markets over the period of 1987 to 2011. Our test is free of the sample selection bias, data mining, hindsight bias, or any of the other usual biases that may affect results in our field. We use the exact same technical trading rules that Brock, Lakonishok and LeBaron (1992) showed to work best in their historical sample. Further analysis shows that this poor out-of-sample performance most likely is not due to the market becoming more efficient - instantaneously or gradually over time - but probably a result of bias.

1. Introduction

Technical analysis studies patterns in historical stock market series generated by day-to-day market activities, with the aim to predict future market movements. The key information technical analysts use is volume and price. We evaluate the profitability of 26 classic technical trading strategies that are formed by using the underlying price on the Dow Jones Industrial Average (DJIA) during the period from 1987 to 2011. These trading rules were first tested extensively by Brock, Lakonishok and LeBaron (1992) which allows us to perform a comprehensive out-of-sample test by using exactly the same trading rules on a fresh new data set that minimises the effect of any possible statistical biases. With the benefit of a fresh dataset, we find little predictability of the 26 technical trading strategies out of sample, which is in strong contrast with their in-sample findings. Further analysis of these out of sample results shows that the profitability of these strategies does not gradually disappear suggesting the market becomes more efficient over time, but trading strategies based on these rules underperform the market from the beginning of our out-of-sample period. While it is possible that all investors started using these technical rules and made the market instantaneously more efficient, it seems more likely that the earlier results are caused by some sort of statistical biases. Particularly because we also find no evidence in another 12 year out-of-sample period from 1885 to 1896. We confirm our out-of-sample results for the same 25 year period for the S&P 500 Index instead of the Dow Jones index. Moreover, the 2008 financial crisis period does not appear to drive our results as the profitability of the 26 technical trading rules also does not persist out-of-sample when we remove the crisis period from our sample. Our study shows the importance of studying new data to safeguard against the danger of possible statistical biases.

The possible danger of biases of all sorts is well known. Jensen and Bennington (1970) indicate that superior trading rule performance is often a consequence of survivorship bias. Merton (1985) points out the danger of selection bias and cognitive bias that could affect the results, while studying the behaviour of stock market returns; Lo and Mackinlay (1990) state that the degree of data snooping bias in a particular field increases with the number of studies published on the topic. In the field of technical analysis, Sullivan, Timmermann and White (1999) utilise the White's Reality Check technique to check for any data snooping bias in particular. However, it is difficult to guard against other statistical biases that could affect the results. Fama (1991) and Lakonishok and Smidt (1988) both provide us with the best solution for these statistical biases: The use of new data. Fama (1991, p 1587) states that: "We should also keep in mind that the CRSP data… are mined on a regular basis by many researchers. Spurious regularities are a sure consequence. Apparent anomalies in returns thus warrant out-of-sample tests before being accepted as regularities likely to be present in future returns". Lakonishok and Smidt (1988) prescribe long and new data series as the best remedy against data snooping, noise and 'boredom' (selection bias). Fortunately, with the passage of time many earlier studies can now be replicated with fresh data. Our study is, therefore, primarily motivated to perform such an out-of-sample test, by having access to another 25 years of out-of-sample data other than that used in Brock, Lakonishok and LeBaron (1992).

The study of Brock, Lakonishok and LeBaron (1992) is an important milestone in the field of technical analysis. Not only because they tested a large number of popular technical trading rules but also because it marks a turning point in the academic view on technical analysis. Before the publication of their work, technical analysis was largely dismissed by academics in the 1960s and

1970s. Although Alexander (1964) provides supportive evidence for the profitability of technical analysis on stock markets by utilising the filter rules, Fama (1965) and Samuelson (1965) both question the value of technical analysis by providing evidence in favour of random walk models. The debate on the usefulness of technical analysis has continued since these studies. But it suffered a relatively quiet period until the beginning of the 1990s. Modern studies in the field of technical analysis are boosted from the beginning of the 1990s, which coincides with the publication of Brock, Lakonishok and LeBaron (1992). According to Park and Irwin (2004, p 17): "The number of technical trading studies over the 1995-2004 period amounts to about half of all empirical studies conducted since 1960". Following the strength of their findings, many studies further confirm the predictive power of their set of technical trading rules in many different economic circumstances. These trading strategies are found to beat the buy-and-hold strategy in different stock markets across the world. For example, Raj and Thurston (1996), Parisi and Vasquez (2000) and Vasiliou, Eriotis and Papathanasiou (2008) provide supportive evidence from the Hong Kong, Chile and Greek markets, respectively. Bessembinder and Chan (1995) take transaction costs into account on six Asian stock markets (Hong Kong, Japan, Korea, Malaysia, Thailand and Taiwan) during the period of 1975 to 1991, with these trading rules again found to significantly beat the buy-and-hold strategy across all markets and all trading rules.

Sullivan, Timmermann and White (1999) find that the results of Brock, Lakonishok and LeBaron (1992) are not altered after taking into account the quantified data snooping effects. They also show that the same significant profitability is not realised in a shorter out-of-sample tests on either the DJIA 1987 to 1996 data, or the S&P 500 futures data. They state at the end of their study that: "…it is possible that, historically, the best technical trading rule did indeed produce superior performance, but that, more recently, the markets have become more efficient and hence such opportunities have disappeared" (Sullivan, Timmermann and White, 1999, p 1684). Bajgrowicz and Scaillet (2012) also show that technical trading rules do not outperform after 1986. Their study uses a different method to account for the data snooping effects. These two studies focus on examining the data snooping adjusted predictability of a large number of technical trading rules (in both cases, they use the same universe of 7,846 technical trading rules). Our study differs as we do not consider a large universe of trading rules but focus on what would have happened to an investor had he or she implemented the 26 trading rules that seemed to performed so well in the past. Our paper also uses a substantially longer new sample of 25 years, which is bias free with respect to the Brock Lakonishok and LeBaron set of trading rules. Last but not least we investigate why these specific technical trading rules might not work. Is that caused by bias or a market becoming (gradually) more efficient with respect to these trading rules over time?

2. Empirical Approach

2.1 Technical Trading Rules

By precisely restricting the settings of the 26 trading rules in line with the original work of Brock, Lakonishok and LeBaron (1992), we aim to deliver a true out-of-sample test. By studying the same trading rules that have been studied extensively in previous research, we mitigate the data snooping

problem by not searching for ex-post successful trading rules. Another benefit of our choosing to replicate their work is that the selected 26 trading rules are themselves representative, being widely used in practice in the long run, as they are basically formulated from the historical stock price patterns, which ensures easy access to data and sufficiently long data series. The 26 trading rules can be further divided into three groups: Variable-Length Moving Average Rules; Fixed-Length Moving Average Rules; and Trading Range Break Rules. We briefly discuss these groups here, as well as trading rules with filters that help to generate more reliable signals.

a) Variable-Length Moving Average Rules

Simply put, a long-term moving average and a short-term moving average of the underlying prices are each calculated for Variable-Length Moving Average rules. If the short-term moving average is below (above) the long-term moving average, a sell (buy) signal is generated. The underlying theory is straightforward: A falling (rising) long-term moving average indicates that the prices are periodically falling (up-trending). Thus, comparing the long-term moving average with the short-term moving average that reflects the current market position produces buy, or sell, trading signals. The difference between the short- and long-term moving averages provides an indication of the strength of the trend and, hence, the trading signal.

Moving averages are customised indicators, with adjustable time frames according to the investor's preference. There are an unlimited number of combinations of the short- and long-term cycles. In our study we apply five combinations following Brock, Lakonishok and LeBaron (1992), namely 1-50, 1-150, 5-150, 1-200 and 2-200. The term Variable-Length refers to the fact that the holding period after trading on the signals is flexible. In other words, it is not forced to hold the position for a certain time period. We hold the current buy (sell) position until a different sell (buy) trading signal is generated. We then study the daily returns conditional on these trading signals.

It is not easy to define the best moving average rules, as economic circumstances vary and investors' behaviours differ. However, the convention is normally that 5-20 periods, 20-60 periods and 100-200 periods are often used to detect short-, medium- and long-term cycles of price movements, respectively.[1] The longer the time period, the less sensitive the trading rule is to current price fluctuations, with less trading signals being generated.

In addition, we also examine - again in line with Brock, Lakonishok and LeBaron (1992) - these five moving average trading strategies, with a percentage filter of 1%. The filter is added to eliminate whipsaws that may generate *fake* trading signals without the support of a solid underlying trend. The filter is defined as the percentage difference between the long-term and short-term moving averages, which has to be greater than 1% for a trading signal to become valid. Hence, there are a total of 10 Variable-Length Moving Average Rules.

[1] The choice of the underlying cycles differs between investors. We describe the convention according to the websites http://www.incrediblecharts.com/indicators/moving_average.php and http://stockcharts.com/school/doku.php?id=chart_school:technical_indicators:moving_averages#lengths_and_timefram

b) Fixed-Length Moving Average Rules

Fixed-Length Moving Average rules work similarly to Variable-Length Moving Averages, the key difference being that a trading signal is only generated when a crossover is discovered. Also, on top of the settings for Variable-Length Moving Average rules, the term *fixed-length* refers to a fixed holding period being required after a trading signal is generated. We use a holding period of 10 days. That is, once a trading signal is generated, we will hold the position for 10 days and all other signals within this 10 day period will be ignored.

This type of time filter is another widely used technique for eliminating whipsaws. The choices of short- and long-term intervals are the same as those for Variable-Length Moving Average rules. We apply the time filter to all of our Fixed-Length Moving Average rules and a 1% filter is also applied at the second stage along with the time filter. There are a total of 10 Fixed-Length Moving Average rules.

c) Trading Range Break Rules

While moving averages give the current price a benchmark for comparison, Trading Range Break rules form a channel for the price to fluctuate. The channel is formed by local extremes; namely support and resistance over the same period, which are defined as moving periodic minimum and maximum prices, respectively. If the price goes beyond either support, or resistance, this signals a possible change in the current trend. A buy signal is generated when the current price rises over the resistance and a sell signal is generated when the current price goes below the support.

We study the same Trading Range Break rules as Brock, Lakonishok and LeBaron (1992): 1-50, 1-150 and 1-200. To illustrate, taking the 1-50 rule as example, when the 1 day price rises over the previous 50 days' maximum price, this signals a buy and when the 1 day price falls below the previous 50 days' minimum price, this signals a sell. Again, we also limit the holding period to 10 days to all three Trading Range Break rules and in the second step the 1% filter is also applied. This gives us six Trading Range Break rules for examination.

2.2 Data

We cover both the Dow Jones Industrial Index (DJIA) and the S&P 500 Composite Price Index in this study. Results generated upon these two series are reliable and meaningful for several reasons. They are both US indices, where the market is widely considered to be more efficient and less subject to problems such as political instability and government intervention than many other markets. The US is also the most important and the largest economy worldwide and both of these indices are historically extensive.

We study the DJIA first in order to link our study directly Brock, Lakonishok and LeBaron (1992). To make sure that our results are not index dependent, we also replicate the same evaluation on the S&P 500. As well as providing for double checking of our results, the S&P 500 is often considered

to be a better proxy for studying the US stock markets than is the DJIA. The S&P 500 contains 500 large companies, which together account for over 75% of the market value of the US stock markets, while the DJIA contains only 30 companies that are the leaders in their particular industries.

We source both the DJIA and the S&P 500 price data from Global Financial Data. We try to gather the longest data where possible, in order to cover all economic circumstances and to, as much as possible, prevent our results from suffering from any sample selection bias. The sample periods for the DJIA can be separated into three parts. The first part covers the period from January 1897 to December 1986. This is the in-sample period studied by Brock, Lakonishok and LeBaron (1992) and we use this sample to provide a brief discussion for their in-sample findings. The second part is our out-of-sample test. It starts directly following the data used in Brock, Lakonishok and LeBaron (1992), that is, it runs from January 1987 to the latest data available for March 2011, giving a 25 year period. The third part is also out-of-sample and serves as a robustness check. It begins in February 1885, which is the starting point of the earliest US stock market index data available at a daily frequency. This sample period lasts until December 1896, just before the start of the sample period of Brock, Lakonishok and LeBaron (1992), totalling a 12 year period. The sample period for the S&P 500 starts from the earliest available daily data; which is for January 1928; to the latest data available (March 2011). Returns are calculated as the log differences of the current period and the last period's closing prices. In order to detect the impact, if any, of the 2008 financial crisis on our results we also apply the trading strategies on the sub-sample periods after removing the crisis period of 2008 to 2011[2].

Table 1 presents detailed summary statistics for both the DJIA and the S&P 500 in the daily and 10-day holding periods. Across the three samples of the DJIA, we can see that both the mean returns and volatilities increase through time. The daily mean return of the DJIA during the period of 1885 to 1896 of 0.003% is the lowest across all three sample periods, with the return ten times that during the recent 25 year sample period, indicating the vigorous development of the stock market.

The average daily and 10-day returns for the DJIA for 1987 to 2011 are 0.031% and 0.30%, respectively, across the 25 year period. The returns on the S&P 500 are 0.0169% and 0.266%, respectively, on daily and 10-day basis, which are lower compared with those of the DJIA, while the volatilities are higher. Not surprisingly, the inclusion of the 2008 financial crisis generates lower returns and higher volatilities.

[Insert Table 1: Summary Statistics]

2.3 Methodology

The selected 26 technical trading rules all generate clear buy, or sell, trading signals. Therefore, we perform our evaluation of their profitability based on studying the mean returns conditional on trading signals across each sample period. The procedure can be separated into two steps, as outlined below.

[2] We try as best as possible to set our sample period in line with Brock, Lakonishok and LeBaron (1992), however, the S&P 500 data is only available from 1928, while the DJIA data is available from 1897.

1) In the first step, buy and sell signals are studied separately. We perform the t-tests to study the differences between the mean buy/sell returns and the same period unconditional indices' returns. This gives us 52 groups of buy/sell signals to study. If the null hypothesis that returns conditional on technical trading signals are not statistically different from the unconditional returns cannot be rejected, the economic value of technical trading rules should be carefully considered.

2) We test the differences between the mean buy returns and the mean sell returns generated by the same trading strategy. This is achieved by using the regression model below with two dummy variables; D_{t-1}^{Buy} and D_{t-1}^{Sell}:

$$r_t = \alpha + \beta_1 D_{t-1}^{Buy} + \beta_2 D_{t-1}^{Sell} + \varepsilon_t \qquad (1)$$

- r_t represents the daily/10 days log returns of the DJIA/ the S&P 500;
- D_{t-1}^{Buy} is a dummy variable that equals 1 when a buy signal is generated and 0 otherwise;
- D_{t-1}^{Sell} is a dummy variable that equals 1 when a sell signal is generated and 0 otherwise; and
- ε_t represents the residual term.

According to the regression model, the average buy and sell returns are captured by $\alpha + \beta_1$ and $\alpha + \beta_2$ respectively. Then, the difference between the average buy and sell returnsis captured by $\beta_1 - \beta_2$.

We then test the null hypothesis of equality between mean buy returns and mean sell returns by applying the Wald test. Under the null hypothesis that technical trading strategies do not produce useful trading signals, buy signals should not differ statistically from sell signals in terms of returns conditional on these trading signals and, thus, β should not be statistically different from zero. We employ the above regression to test the spread between returns conditional on buy and sell signals rather than following the original t-test utilised by Brock, Lakonishok and LeBaron (1992). This allows us to easily implement the Newey-West correction on the standard errors to avoid autocorrelation and heteroskedasticity effects to influence significance levels, while Brock, Lakonishok and LeBaron (1992) utilise the bootstrap methodology to address these statistical aspects.

3. Empirical Results

3.1 In-sample results on the DJIA 1897-1986

Before reporting our out-of-sample findings, we first provide some brief discussion here on the in-sample findings of Brock, Lakonishok and LeBaron (1992). We duplicated their results by using our methodology on the same DJIA 1897 to 1986. The Wald test statistics, rather than the original t-statistics, are reported, with the conclusions drawn from these two statistical tests being basically the same. We ensure the accuracy of the settings of the 26 trading strategies by doing this. This also allows us to link and compare the in-sample and out-of-sample results. Table 2 contains our results.

[Insert Table 2: Results on the DJIA 1897-1986]

The first and second columns of Table 2 give the time period and the trading rules we examined. For each group of trading rules, we test these both with and without the 1% percentage filters. For each trading rule, the first and second figure in brackets represent the underlying long- and short-term cycles in days, respectively, and the third figure represents the percentage filter. For example, the Variable-Length Moving Average rule (2, 200, 0.01) tells us that buy (sell) signals are generated when the 2 day moving average of the DJIA is above (below) the 200 day moving average, and that the trading signal is only valid when the difference between the two moving averages is over 1%. The results show that the introduction of filters eliminates some weak trading signals. Also, the longer the time frame of the underlying moving averages, the greater the number of variations on the prices that are smoothed out, hence the lower the number of trading signals generated.

The following three columns report the number of buy trading signals generated by each trading rule, the mean returns conditional on these buy signals, and the t statistics of testing the difference between buy returns and the unconditional buy-and-hold returns. We then repeat this for sell trading signals in the next three columns. The results reveal that buy (sell) signals consistently produce positive (negative) returns across the 90 year sample period. Most of these conditional returns are also found to be statistically different from the buy-and-hold returns at the 10% significance level, with the rest being marginally significant. The Variable-Length Moving Average strategies outperform the Fixed-Length Moving Average strategies and the Trading-Range Break strategies, with all 20 groups of trading signals beating the buy-and-hold strategy.

The last two columns report the Wald test results for testing the differences between buy returns and sell returns. These results are even stronger. Across all 26 trading strategies, we consistently find that buy returns are significantly different from the same period sell returns at the 10% level of significance. The in-sample results provide strong supportive evidence -for the argument that technical trading strategies produce useful trading signals.

Our results are not surprisingly similar to Brock, Lakonishok and LeBaron (1992). For example, we find that the Variable-Length Moving Average rule (1, 50, 0) generates 14420 buy signals and 10617 sell signals that totals 25037 signals across the 90 year sample period, and Brock, Lakonishok and LeBaron (1992) reports 14240 buy signals and 10531 sell signals. Our mean buy (sell) return for this trading rule is 0.050% (-0.027%) while they report 0.047% (-0.029%). Overall across all 26 trading strategies, we find 19 (20) groups of buy (sell) signals producing returns higher than the buy-and-hold returns at the 10% significance level, while Brock, Lakonishok and LeBaron (1992) report 19 (19) groups of buy (sell) signals. Moreover, our Wald test results indicates that all the 26 trading rules produce different buy returns from sell returns, while Brock, Lakonishok and LeBaron (1992) provides the answer of 25 to the same question although they use a t-test instead.

3.2 Out-of-sample Results on the DJIA 1987-2011

We report our results on the DJIA from 1987 to 2011 in Table 3. Overall, we find no evidence supporting the predictability of the technical trading rules. Our out-of-sample findings are in sharp contrast with the findings of the in-sample results.

[Insert Table 3: Results on the DJIA 1987-2011]

The out-of-sample results are tabulated in the same way as the in-sample results. Again there are generally more buy signals than sell signals, which is consistent with the overall uptrending of the DJIA. The Variable-Length Moving Average strategies generate significantly more trading signals across all three categories of our trading strategies, with an average of 223.38 trading signals per year, compared with only 4.35 signals per year generated by the Fixed-Length Moving Average rules and 5.97 signals per year generated by the Trading-Range Break rules. The average frequencies of the trading signals do not vary much from the in-sample period. The Variable-Length Moving Average strategies produces 37 more signals per year in-sample (260.91 signals annually), the Fixed-Length Moving Average strategies and the Trading-Range Break Rules generate 3.95 and 6.73 trading signals annually in-sample, respectively.

Brock, Lakonishok and LeBaron (1992) find that buy (sell) signals during their sample period from 1897 to 1986 are consistently generating positive (negative) returns, which are significantly higher than the same period buy-and-hold returns. In our case, however, we find that, out of the total 52 groups of signals, only five groups of trading signals produce statistically different returns from the unconditional returns and are all sell signals. None of the buy returns are found to be different from the buy-and-hold returns.

The findings on the sell signals from the Trading Range Break rules are especially remarkable: The trading rules (1,150), (1,200), (1,150, 0.01) and (1,200, 0.01) produce predictable sell signals with positive mean returns that are statistically significant at the 90% level. The mean returns of these sell signals range from 1.93% to 2.73%, all being quite substantial compared with the 10-day unconditional mean return of 0.30%. The positive mean returns of the sell signals indicate that the sell signals inversely predict the market. Brock, Lakonishok and LeBaron (1992) documented in their study that:

> "The negative returns in Table II for sell signals are especially noteworthy. These returns cannot be explained by various seasonalities since they are based on about 40 percent of all trading days. Many previous studies found as we did that returns are predictable. This predictability can reflect either: (1) changes in expected returns that result from an equilibrium model, or (2) market inefficiency. In general, it is difficult to distinguish between these two alternative explanations. Although rational changes in expected returns are possible it is hard to imagine an equilibrium model that predicts negative returns over such a large fraction of trading days" (p. 1740).

In contrast, it is interesting that in our case, through examining the same DJIA index out-of-sample data from 1987 to 2011, instead of the negative returns detected in their study, we find that most sell returns are positive.

The Wald test results from the last two columns show that, among the 26 trading rules, three trading rules are found to generate significantly different buy and sell returns at the 90% significance level. The spread between the signals is, however, negative, which actually indicates that the buy, the sell, or both signals predict the market in the opposite direction. These negative values are again in contrast with the findings of Brock, Lakonishok and LeBaron (1992), in which positive spreads are always discovered. Nevertheless, such negative values of mean buy-sell spreads would not be surprising with the positive mean sell returns that we detected earlier.

3.3 Three Hypotheses

Our out-of-sample findings differ largely with what is found in-sample. We present three hypotheses in attempting to explain why the predictability of the 26 simple technical trading strategies disappears:

(1) The 26 simple technical trading strategies simply do not work. The in-sample results with predictability discovered are subject to possible statistical biases. In this case we would not find significant results in both our sample from 1987 to 2011, and during the earlier sample periods from 1885 to 1896.
(2) While the 26 simple technical trading strategies could have been profitable during the 90 year in-sample period, the stock market is gradually becoming more efficient with respect to the information of technical trading rules after the Brock, Lakonishok and LeBaron (1992). Thus, the predictability of these trading rules is gradually eliminated. The outperformance of these trading strategies would gradually disappear over time in our 1987-2011 sample but still be present from 1885 to 1896.
(3) The 26 simple technical trading strategies do generate superior returns during the 90 year period; however, investors are informed immediately of the Brock, Lakonishok and LeBaron (1992) results and discover the profitability of the 26 trading strategies. They implement these strategies straightaway, to the extent when these trading strategies are no longer profitable. The predictability disappears immediately in 1987 but is still present in our earlier sample period of 1885 to 1896.

3.4 The Profitability Over Time

To illustrate the changed predictability over time, Figures 1, 2 and 3 present the cumulative wealth of investing on the Variable-Length Moving Average strategy (1, 50). We also plot the cumulative wealth for the buy-and-hold strategy for comparison. To save space, we use this as an example to illustrate the profitability of the technical trading strategies over time, while the results on the remaining 25 trading strategies are similar.

The plots are given on a 5 year panel, a 10 year panel and the full 25 year panel since 1987. We assume that we invest one dollar on the DJIA on the first trading day of 1987, that we long on buy trading signals and that we short sale on sell trading signals. We invest in risk-free assets when there is no trading signal. The 3-month US T-bill rate is used as the risk-free rate.

Figure 1 shows that during the 5 year period from 1987 to 1991, the technical trading strategy does not beat the buy-and-hold strategy over most of the period. It wins the buy-and-hold strategy only during the 1987 financial crisis period. We then extend the underlying period to 10 years from 1987 to 1995 in Figure 2. The cumulative wealth of the buy-and-hold strategy gradually increases, associated with the stock markets' growth during this period. At the same time, however, the cumulative wealth of the technical trading strategy remains flat. This causes the gap in the cumulative wealth between the buy-and-hold strategy and the Variable-Length Moving Average strategy (1, 50) to expand more and more during this period. At the end of 1995, the cumulative wealth of the buy-and-hold strategy and the technical trading strategy are $2.27 and $1.08 respectively, from the $1 initial investment. Last, in Figure 3, it is observed that the cumulative wealth of the buy-and-hold strategy fluctuates across the full 25 year sample period. The end-of-period wealth reaches $3.87 by investing on the buy-and-hold strategy, while at the same time the cumulative wealth line over time remains flat for the (1, 50) rule with an end-of-period wealth of $0.85 by the end of March in 2011. Overall, the cumulative wealth of the variable-length moving average rule ranges between $0.55 and $1.41, which is relatively flat across the full 25 year period and seldom beats the market.

While lower returns could be a result of lower risk. We next examine the profitability of the technical trading strategies on a risk-adjusted basis by estimating Jensen's α:

$$r_t^p - r_t^f = \alpha + \beta\,(r_t^m - r_t^f) + \varepsilon_t \qquad (2)$$

- r_t^p represents the log return on technical trading strategies;
- r_t^f represents the risk free rate, which is set as the US 3-month Treasury Bill rate;
- r_t^m represents the return on the DJIA index; and
- ε_t represents the residual term.

The excess return over what is expectedand the systematic risk of the technical trading strategy are captured by α and β, respectively. We report the results in Table 4 with the t-statistics (based on White standard errors) in brackets.

[Insert Table 4: Results for Jensen's α Estimation on the DJIA 1987-2011]

We study technical trading strategies that employ buy signals only, or sell signals only, or both buy and sell signals separately, in comparison with a buy-and-hold strategy:

- Buy Only: We only long when there is a buy trading signal generated, otherwise we invest in risk-free assets.
- Sell Only: We only short sell when there is a sell trading signal generated, otherwise we invest in risk-free assets.
- Buy and Sell: We long on buy trading signals and short on sell trading signal; we invest in risk-free assets when there is no trading signal.
- Buy and Hold: We invest on the DJIA throughout.

Table 4 gives α and β estimates for each of these trading rules separately. No matter whether we employ buy signals only, or sell signals only, none of these 26 trading strategies are shown to

generate positive significant α. In addition, a few trading strategies, namely the Fixed-Length Moving Average rule (1,50,0.01), (1,200, 0.01), (2,200,0.01) and the Trading Range Break rule (1,150,0) are found to generate negative significant α when we invest on both buy and sell trading signals. These negative significant α indicate that, for a given risk level, investing on these technical trading strategies is not as profitable as investing on the market. Overall, the absence of positive significant α reveals that technical trading strategies do not generate superior returns on a risk-adjusted basis either. We also calculate the Henriksson & Merton (1981) market timing coefficient and the Sharpe ratios; they capture different perspectives of the risk/return trade-off. The results are available in Appendix A, with similar findings that do not favour the technical trading strategies on a risk-adjusted basis. This suggests that we can rule out the hypothesis that technical trading rules were gradually implemented by traders. This leaves us with two alternatives. Either a large group of investors immediately acted upon a trading strategy in 1987 when the sample period of Brock, Lakonishok and LeBaron (1992) ends and this made the market more efficient, or the results are caused by statistical bias.

3.5 Results on the DJIA 1885-1896

We further test the profitability of the same 26 technical trading rules on the DJIA from 1885 to 1896, which totals a 12 year period. As well as double checking whether the in-sample results are sample specific, it could also help in identifying the role that a more efficient market is playing in the changed predictability. That is, if the disappearing predictability of the technical trading strategies is the result of a more efficient market, we should not be able to detect similar disappearing predictability during the period from 1885 to 1896.

[Insert Table 5: Results on the DJIA 1885-1896]

The results are presented in Table 5. Again, the technical trading strategies show limited predictability during this period. At the 10% significance level, seven out of the total fifty-two groups of buy/sell trading signals are found to produce higher mean returns than the simple buy-and-hold returns.

The results are presented in Table 5. Again, the technical trading strategies show limited predictability during this period. At the 10% significance level, only seven out of the total fifty-two groups of buy/sell trading signals are found to produce higher mean returns than the simple buy-and-hold returns. This seems only slightly more than one would expect under the null hypothesis of no predictability. It is also noteworthy that even for the seven significant results; nearly all of them come from the Fixed-Length Moving Average rules and the Trading range Break rules. Both of these two types of trading rules have relatively less trading signals due to a fixed holding period of 10 days. For instance, the Trading Range Break rule (1, 200, 0.01) only generates 7 buy signals and 12 sell signals during the 12 year period. The predictability of the seven groups of trading signals may be further challenged when we realize that this may be due to a limited number of signals for many of these trading rules.

Moreover, we find none of the sell signals shows any predictability in the 12 year period, which contrasts with the in-sample findings that sell signals tend to show more predictability. And the Wald test results in the last column indicate that in nineteen cases out of twenty-six in total, the buy-sell spreads are not different from zero, showing that the majority of the simple technical trading strategies do not produce useful signals.

[Insert Table 6: Results for Jensen's α Estimation on the DJIA 1885-1896]

We present the results for Jensen's α estimation for the period 1885 to 1896 in Table 6. Out of seventy-eight trading strategies only twelve produce positive αs. Again this number might even be biased upward as most of the twelve trading strategies only generate a small number of signals during the 12 year period. This provides evidence that the reduced predictability of the simple technical trading strategies is not associated with a reduced risk level neither during the period from 1885 to 1896.

In general, we find that strong supportive results in-sample could not be realised out-of-sample in the most recent 25 years. The consistently lower profit across the 25 year period compared with the simple buy-and-hold strategy could also not be explained by lower risk. Furthermore, the results on the 12 year period from 1885 to 1896 confirm that the results of Brock, Lakonishok and LeBaron (1992) tend to be sample specific, and that a more efficient market does not also appear to cause the disappearing profitability out-of-sample. Among the three hypotheses possible statistical bias seems the most likely explanation for the absence of profitability of these trading rules out-of-sample.

3.7 Other Robustness Checks

We also perform our evaluation excluding the 2008 financial crisis period from January 2008 to March 2011, with the results found to be robust. This could probably lend some support to the concern of Sullivan, Timmermann and White (1999), that the 1987 financial crisis could also alter their findings of decreased predictability of the technical trading rules.[3]

Also, by considering the S&P 500 as a more popular proxy to construct a full story across time, we duplicate the evaluations for the trading rules on the S&P 500 data for the period of 1928 to 2011. To save space, the results are not reported. Nonetheless, the findings are similar: The technical trading strategies do work during the period before 1986, whereas such profitability disappears since 1987.

4 Conclusion

With the benefit of a fresh 25 year out of sample period we are able to perform a truly out of sample test of Brock, Lakonishok and LeBaron (1992). We find no evidence that 26 popular technical trading rules tested by Brock, Lakonishok and LeBaron (1992) have statistically significant predictability out of sample. The predictability is gone at the beginning of our 25 year sample, when

[3] As the results are similar whether, or not, the 2008 financial crisis period is included, we do not report them here in this study for either the DJIA, or the S&P 500, due to space restraints.

their sample ends. As we also find no evidence in an earlier fresh sample from 1885 to 1896, this suggests not the market has become more efficient over time but more likely that some sort of bias might have caused the in sample predictability result.

References

Alexander, S. S. (1964). Price Movements in Speculative Markets: Trends or Random Walks. *Industrial Management Review, 2*(2), 7-26.

Bajgrowic, P. & Scaillet, O. (2012). Technical Trading Revisited: False Discoveries, Persistence Tests, and Transaction Costs. *Journal of Financial Economics Forthcoming.*

Bessembinder, H. & Chan, K. (1995). The profitability of technical trading rules in the Asian stock markets. *Pacific-Basin Finance Journal, 2*(2-3), 257-284.

Brock, W., Lakonishok, J. & LeBaron, B. (1992). Simple Technical Trading Rules and the Stochastic Properties of Stock Returns. *Journal of Finance, 47*(5), 1731-1764.

De Roon, F., Eiling, E., Gerard, B. & Hillion, P. (2011). Speculative Profits or Hedging Benefits? Currency Investing in Global Portfolios. *Working Paper.*

Fama, E. F. (1965). The Behavior of Stock-Market Prices. *The Journal of Business, 38*(1), 34-105.

Fama, E. F. (1991). Efficient Capital Markets II. *The Journal of Business, 46*(5), 1575-1617.

Henriksson, R. D. & Merton, R. C. (1981). On Market Timing and Investment Performance II. Statistical Procedures for Evaluating Forecasting Skills, *Journal of Business, 54*(4), 513-533.

Jensen, M. & Bennington, G. (1970). Random Walks and Technical Theories: Some Additional Evidence. *The Journal of Business, 25*(2), 469-482.

Lakonishok, J. & Smidt, S. (1988). Are Seasonal Anomalies Real? A Ninety-Year Perspective. *Review of Financial Studies, 1*(4), 403-425.

Lo, A. W. (2002). The statistics of Sharpe ratios. *Financial Analyst Journal, 58*(4), 36-52.

Lo, A. W. & MacKinlay, A. C. (1990). Data-snooping biases in tests of financial asset pricing models. *Review of Financial Studies, 3*(3), 431-468.

Merton, R. C. (1985). On the current state of the stock market rationality hypothesis. *Working Paper No. 1717-85,* MIT, Sloan School of Management.

Newey, W. K. & West, K. D. (1987). A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica 55* (3), 703-708.

Parisi, F. & Vasquez, A. (2000). Simple technical trading rules of stock returns: Evidence from 1987 to 1998 in Chile. *Emerging Markets Review, 1*(2), 152-164.

Park, C.-H. & Irwin, S. H. (2004). The Profitability of Technical Analysis: A Review. *AgMAS Project Research Report 2004-2004*. Urbana, Il: University of Illinois at Urbana-Champaign.

Raj, M. & Thurston, D. (1996). Effectiveness of Simple Technical Trading Rules in the Hong Kong Futures Markets. *Applied Economics Letters, 3*(1), 33-36.

Samuelson, P. A. (1965). Proof That Properly Anticipated Prices Fluctuate Randomly. *Industrial Management Review, 6*(2), 41-49.

Sullivan, R., Timmermann, A. & White, H. (1999). Data-Snooping, Technical Trading, Rule Performance and the Bootstrap. *Journal of Finance, 54*(5), 1647-1691.

Vasiliou, D., Eriotis, N. & Papathanasiou, S. (2008). Technical Trading Profitability in Greek Stock Market. *The Empirical Economics Letters, 7*(7), 749-756.

White, H. (1980), A Heteroscedasticity Consistent Covariance Matrix Estimator and A Direct Test of Heteroskedasticity. *Econometrica, 48*(4), 817-838.

Appendix A：Performance Evaluations of the Trading Strategies on the DJIA 1987-2011

In this appendix we further evaluate the profitability of the technical trading strategies in comparison with a buy-and-hold strategy. For each trading strategy, we can either long on buy signals only, or otherwise invest in risk-free assets; or short sales on sell signals only, or otherwise invest in risk-free assets; or long on buy signals and short sales on sell signals and invest in risk-free assets when there is no trading signal.

Table A gives the results comparing the Sharpe Ratios of the technical trading strategies and the buy-and-hold strategy on the DJIA from 1987 to 2011. The Sharpe Ratios are estimated by using:

$$\text{Sharpe Ratio} = (r_t^p - r_t^f)/\sigma_t^p \qquad (1)$$

in which r_t^p represents the returns of technical trading strategies, r_t^f represents the risk free rate which is set as the US 3-month Treasury Bill rates and σ^p represents the standard deviation of r_t^p. We also perform the significance test examining the differences between the Sharpe Ratios of the technical trading strategies and the Sharpe Ratio of the buy-and-hold strategy. The significance test are performed according to the methodology proposed by Lo (2002) and De Roon, Eiling, Gerard, and Hillion (2011), which assumes that the excess returns $r_t^p - r_t^f$ are *i.i.d.* normal.

[Insert Table A: Results for the Sharpe Ratio Estimation 1987-2011]

It is found that, for the variable-length moving average strategies, none of their Sharpe Ratios are significantly higher than the same period buy-and-hold Sharpe Ratio. For the Fixed-Length Moving Average strategies and the Trading Range Break strategies, which both have a 10 day holding period, we find most of the Sharpe Ratios are significantly lower than the buy-and-hold Sharpe Ratio. The Sharpe Ratio captures excess returns compensated for each unit of risk. Our results in Table A show that none of our technical trading strategies pay more for extra risk than does the buy-and-hold strategy, whereas some of the technical trading rules even suffer a reduction in profit for taking each extra unit of risk. It makes no difference whether we invest on either buy, or sell signals only, or on both of them.

Table A: Results for the Sharpe Ratio Estimation 1987-2011

This table reports results for the Sharpe ratio estimation: Sharpe Ratio= $(r_t^p - r_t^f)/\sigma_t^p$ for the DJIA 1987-2011, where r_t^p represents the returns of technical trading strategies, r_t^f represents the risk free rates which is set as the US 3-month Treasury Bill rate and σ^p represents the standard deviation of r_t^p. Trading rules are written as (short, long, band), where short and long represent the short and long moving averages, respectively. A 1% price change is used as the band. The t-test results, which test the differences of the Sharpe ratios on technical trading strategies from the Sharpe ratios of the buy-and-hold strategy, are reported in the brackets, and are White standard error corrected and marked in bold if they are significant at the 10% significance level.

Period	Trading Rules	$Sharpe_{Buy}(*10^{-3})$	$Sharpe_{sell}(*10^{-3})$	$Sharpe_{Buy\&Sell}(*10^{-3})$	$Sharpe_{Buy\&Hold}(*10^{-3})$
			VMA Daily		
1987-2011	**(1,50,0)**	1.03	-1.72	-0.77	1.56
		(0.45)	(1.33)	(1.12)	
	(1,150,0)	1.07	-1.34	-0.43	1.56
		(0.42)	(1.17)	(0.95)	
	(5,150,0)	0.87	-1.50	-0.65	1.56
		(0.60)	(1.24)	(1.07)	
	(1,200,0)	1.61	-1.73	-0.34	1.56
		(0.03)	(1.33)	(0.93)	
	(2,200,0)	1.37	-1.92	-0.63	1.56
		(0.17)	(1.41)	(1.07)	
			VMA Daily Band=1%		
1987-2011	**(1,50,0.01)**	0.16	-1.49	-1.13	1.56
		(1.10)	(1.24)	(1.26)	
	(1,150,0.01)	1.30	-1.33	-0.29	1.56
		(0.21)	(1.17)	(0.88)	
	(5,150,0.01)	1.56	-1.32	-0.11	1.56
		(0.00)	(1.17)	(0.80)	
	(1,200,0.01)	1.84	-2.11	-0.52	1.56
		(0.23)	(1.50)	(1.01)	
	(2,200,0.01)	1.60	-2.00	-0.56	1.56
		(0.03)	(1.45)	(1.03)	
			FMA 10-days		
1987-2011	**(1,50,0)**	0.86	-2.42	-1.05	5.73
		(2.82)	**(4.24)**	**(3.71)**	
	(1,150,0)	-0.69	0.49	0.17	5.73
		(3.67)	**(2.68)**	**(2.96)**	
	(5,150,0)	-0.72	1.02	0.68	5.73
		(3.62)	**(2.45)**	**(2.70)**	
	(1,200,0)	-0.02	-2.49	-1.29	5.73
		(3.27)	**(4.27)**	**(3.82)**	
	(2,200,0)	-0.03	-3.02	-1.45	5.73
		(3.27)	**(4.58)**	**(3.94)**	
			FMA 10-days Band=1%		
1987-2011	**(1,50,0.01)**	-0.61	-2.98	-2.34	5.73
		(3.71)	**(4.54)**	**(4.49)**	
	(1,150,0.01)	-1.30	-1.22	-1.54	5.73
		(4.00)	**(3.56)**	**(3.85)**	
	(5,150,0.01)	0.18	-1.08	-0.43	5.73
		(3.10)	**(3.56)**	**(3.29)**	

	(1,200,0.01)	-1.11	-4.86	-3.39	5.73
		(3.92)	**(5.53)**	**(5.05)**	
	(2,200,0.01)	-1.49	-4.21	-3.50	5.73
		(4.08)	**(5.19)**	**(5.04)**	
			TRB 10-days		
1987-2011	**(1,50,0)**	-1.12	-1.70	-1.99	5.73
		(4.01)	**(3.74)**	**(4.07)**	
	(1,150,0)	-0.95	-3.10	-2.85	5.73
		(3.84)	**(4.50)**	**(4.56)**	
	(1,200,0)	-0.37	-2.81	-2.13	5.73
		(3.48)	**(4.35)**	**(4.17)**	
			TRB 10-days Band=1%		
1987-2011	**(1,50,0.01)**	0.58	-0.33	0.00	5.73
		(2.93)	**(3.07)**	**(2.96)**	
	(1,150,0.01)	-0.65	-1.76	-1.61	5.73
		(3.57)	**(3.86)**	**(3.85)**	
	(1,200,0.01)	-0.78	-2.46	-2.15	5.73
		(3.63)	**(4.19)**	**(4.12)**	

At the same time we conduct the Henriksson & Merton (1981) market timing ability test by running the regression:

$$r_t^p - r_t^f = \alpha + \beta\,(r_t^m - r_t^f) + c\,(r_t^m - r_t^f)\,D_{t-1} + \varepsilon_t \qquad \textbf{(2)}$$

in which r_t^p represents the returns of the technical trading strategies, r_t^f represents the risk free rate which is set as the US 3-month Treasury Bill rates and r_t^m represents the return on the DJIA index. D_{t-1} is a dummy variable that equals 1 when $r_t^m > r_t^f$ and 0 otherwise. c measures the market timing ability of the technical trading strategies, that is, if the technical trading strategies could correctly shift between risk-free assets and the market, depending on whether the market is expected to outperform the risk-free assets. A positive value of c indicates successful timing as the extra payoff when the market is up.

[Insert Table B: Results for the Henriksson & Merton Market Timing Ability Estimation 1987-2011]

The results are presented in Table B. We again cover all three ways of implementing a technical trading strategy: Invest on buy signals only; invest on sell signals only; or invest on both buy and sell signals. We find that none of the variable-length moving average trading strategies shows a positive significant timing coefficient c. There is one fixed-length moving average strategy (5, 150, 0) that is found to have a significant positive c value of 0.01 when investing on both buy and sell signals. Also, one trading range break strategy (5, 150, 0.01) is found to have the same significant positive c value of 0.01 while implementing buy signals only. These positive significant c values show some timing ability, while the rest of the Fixed-Length Moving Average and Trading Range Break strategies all have a non-significant c, or negative significant c. In general, we discover hardly any desirable market timing ability for these technical trading strategies.

Table B: Results for the Henriksson & Merton Market Timing Ability Estimation 1987-2011

This table reports the results for the regression model: $r_t^p - r_t^f = \alpha + \beta (r_t^m - r_t^f) + c (r_t^m - r_t^f) D_{t-1} + \varepsilon$ for the DJIA 1987-2011, where r_t^p represents the returns of the technical trading strategies, r_t^f represents the risk free rate which is set as the US 3-month Treasury Bill rate and r_t^m represents the return on the DJIA index. D is a dummy variable that equals 1 when $r_t^m > r_t^f$ and 0 otherwise. C measures the market timing ability of the technical trading strategies. Trading rules are written as (short, long, band) where short and long represent the short and long moving averages, respectively. A 1% price change is used as the band. The t-statistics are reported in brackets, which are White standard error corrected and marked in bold if they are significant at the 10% significance level.

Period	Trading Rules	C_{Buy}	C_{sell}	$C_{Buy\&Sell}$
		VMA Daily		
1987-2011	**(1,50,0)**	0.03	0.03	0.07
		(0.37)	(0.33)	(0.35)
	(1,150,0)	0.04	0.03	0.07
		(0.38)	(0.34)	(0.36)
	(5,150,0)	0.04	0.04	0.09
		(0.45)	(0.41)	(0.43)
	(1,200,0)	-0.06	-0.06	-0.12
		(-1.01)	(-1.08)	(-1.04)
	(2,200,0)	-0.06	-0.07	-0.13
		(-1.11)	(-1.18)	(-1.15)
		VMA Daily Band=1%		
1987-2011	**(1,50,0.01)**	0.02	0.04	0.07
		(0.29)	(0.40)	(0.36)
	(1,150,0.01)	0.03	0.04	0.08
		(0.36)	(0.42)	(0.39)
	(5,150,0.01)	0.05	0.04	0.09
		(0.51)	(0.40)	(0.45)
	(1,200,0.01)	-0.05	-0.08	-0.13
		(-0.87)	(-1.40)	(-1.17)
	(2,200,0.01)	-0.06	-0.08	-0.14
		(-1.09)	(-1.29)	(-1.21)
		FMA 10-days		
1987-2011	**(1,50,0)**	0.00	-0.01	-0.01
		(-0.54)	(-1.27)	(-1.15)
	(1,150,0)	-0.01	0.02	0.02
		(-0.67)	(0.8)	(0.57)
	(5,150,0)	0.00	0.01	0.01
		(1.13)	(1.52)	**(1.81)**
	(1,200,0)	0.00	0.00	0.00
		(0.04)	(-0.41)	(-0.22)
	(2,200,0)	-0.01	0.00	-0.01
		(-0.56)	(-1.39)	(-0.87)
		FMA 10-days Band=1%		
1987-2011	**(1,50,0.01)**	-0.01	-0.01	-0.02
		(-0.89)	**(-1.98)**	(-1.62)
	(1,150,0.01)	-0.01	0.03	0.02
		(-0.56)	(0.8)	(0.61)
	(5,150,0.01)	0.01	0.00	0.01
		(2.01)	(0.25)	(1.18)

	(1,200,0.01)	-0.01	-0.01	-0.02
		(-1.03)	**(-2.41)**	(-1.53)
	(2,200,0.01)	-0.01	-0.01	-0.01
		(-1.21)	**(-1.89)**	**(-1.92)**
		TRB 10-days		
1987-2011	**(1,50,0)**	0.00	-0.02	-0.02
		(0.34)	(-0.55)	(-0.5)
	(1,150,0)	0.00	-0.05	-0.05
		(-0.1)	**(-2.17)**	**(-2.14)**
	(1,200,0)	0.00	-0.04	-0.04
		(-1.06)	(-1.64)	**(-1.77)**
		TRB 10-days Band=1%		
1987-2011	**(1,50,0.01)**	0.01	0.02	0.03
		(1.5)	(0.59)	(0.73)
	(1,150,0.01)	0.00	-0.02	-0.02
		(0.91)	(-1.37)	(-1.25)
	(1,200,0.01)	0.00	-0.02	-0.02
		(0.16)	(-1.21)	(-1.18)

Table 1: Summary Statistics

	The S&P 500			The DJIA			
Sample Period	1928-1986	1987-2011	1987-2007	1885-1896	1897-1986	1987-2011	1987-2007
	Panel A: Daily Returns						
Mean (%)	0.016	0.027	0.033	0.003	0.017	0.031	0.036
Std Dev	0.011	0.012	0.011	0.008	0.011	0.012	0.011
Minimum	-0.132	-0.229	-0.229	-0.068	-0.137	-0.256	-0.256
Maximum	0.154	0.110	0.087	0.055	0.143	0.105	0.097
N	15885	6170	5359	3592	25086	6139	5296
	Panel B: 10-days Returns						
Mean (%)	0.166	0.266	0.328	0.019	0.166	0.301	0.359
Std Dev	0.038	0.034	0.031	0.027	0.036	0.034	0.032
Minimum	-0.374	-0.378	-0.378	-0.163	-0.396	-0.418	-0.418
Maximum	0.291	0.196	0.143	0.161	0.305	0.172	0.153
N	15876	6161	5350	3583	25077	6130	5287

Table 2: Results on the DJIA 1896-1987

This table reports the results on the DJIA 1896-1987. Trading rules are written as (short, long, band), where short and long represent the short and long moving averages, respectively. A 1% price change is used as the band. N (buy) and N (sell) represent the number of buy/sell trading signals. Buy/Sell represents the mean returns conditional on buy/sell trading signals and the associated t-statistics report the t-test results of the differences of the buy/sell returns from the buy-and-hold returns. The last two columns report βs, which are differences between mean buy and sell returns, and the associated Wald-statistics. β equals the differences of β_1 and β_2, which are estimated by the Regression Model $R_t = \alpha + \beta_1 D_{t-1}^{Buy} + \beta_2 D_{t-1}^{Sell} + \varepsilon_t$, where R_t represents the returns conditional on buy/sell signals, and D_{t-1}^{Buy} and D_{t-1}^{Sell} are dummy variables that equal 1 when a buy, or sell, signal is generated and 0 otherwise. The Wald-statistic is Newey-West corrected and marked in bold if it is significant at the 10% level.

Period	Trading Rules	N(Buy)	Buy (*10^{-3})	t-statistics	N(Sell)	Sell (*10^{-3})	t-statistics	β (*10^{-3})	Wald-stats
				VMA Daily					
1897-1986	**(1,50,0)**	14420	0.50	**3.01**	10617	-0.29	**-3.71**	0.79	**29.63**
	(1,150,0)	15042	0.43	**2.37**	9895	-0.24	**-3.18**	0.66	**18.90**
	(5,150,0)	15037	0.38	**1.96**	9900	-0.17	**-2.64**	0.55	**12.87**
	(1,200,0)	15348	0.41	**2.20**	9539	-0.25	**-3.20**	0.65	**17.40**
	(2,200,0)	15362	0.39	**2.04**	9525	-0.22	**-3.00**	0.61	**14.83**
				VMA Band=1% Daily					
1897-1986	**(1,50,0.01)**	11810	0.64	**4.02**	8201	-0.35	**-3.77**	0.99	**32.97**
	(1,150,0.01)	13713	0.45	**2.51**	8622	-0.30	**-3.47**	0.75	**19.60**
	(5,150,0.01)	13650	0.41	**2.15**	8610	-0.21	**-2.84**	0.62	**13.60**
	(1,200,0.01)	14233	0.42	**2.28**	8539	-0.31	**-3.60**	0.74	**19.09**
	(2,200,0.01)	14223	0.39	**2.04**	8532	-0.25	**-3.08**	0.64	**14.16**
Average			0.44			-0.26		0.70	

Period	Trading Rules	N(Buy)	Buy (*10^{-3})	t-statistics	N(Sell)	Sell (*10^{-3})	t-statistics	β (*10^{-3})	Wald-stats
				FMA Holding Period=10 days					
1897-1986	**(1,50,0)**	342	3.33	0.86	347	-4.35	**-3.12**	7.67	**7.98**
	(1,150,0)	158	6.26	1.62	189	-0.74	-0.92	7.00	**2.88**
	(5,150,0)	133	7.13	**1.77**	141	-0.38	-0.68	7.52	**3.32**
	(1,200,0)	115	4.76	0.93	158	-2.51	-1.47	7.28	**3.13**
	(2,200,0)	110	4.26	0.76	143	-4.73	**-2.14**	8.99	**4.22**
				FMA Band=1% Holding Period=10 days					
1897-1986	**(1,50,0.01)**	313	5.58	**1.94**	324	-4.54	**-3.11**	10.12	**12.49**
	(1,150,0.01)	172	6.74	**1.87**	159	-4.59	**-2.20**	11.34	**7.00**
	(5,150,0.01)	128	5.91	1.35	126	-4.42	**-1.91**	10.32	**4.62**
	(1,200,0.01)	133	5.24	1.16	129	-9.46	**-3.53**	14.70	**10.24**
	(2,200,0.01)	118	1.39	0.08	118	-10.19	**-3.60**	11.58	**4.82**
Average			5.06			-4.59		9.65	

Period	Trading Rules	N(Buy)	Buy (*10^{-3})	t-statistics	N(Sell)	Sell (*10^{-3})	t-statistics	β (*10^{-3})	Wald-stats
				TRB Holding Period=10 days					
1897-1986	**(1,50,0)**	733	4.92	**2.44**	417	-0.24	-1.08	5.15	**4.12**
	(1,150,0)	520	4.89	**2.05**	218	-3.23	**-2.02**	8.13	**4.52**
	(1,200,0)	473	4.63	**1.80**	187	-2.61	-1.63	7.24	**2.92**
				TRB Band=1% Holding Period=10 days					
1897-1986	**(1,50,0.01)**	252	8.26	**2.93**	253	-1.88	-1.57	10.14	**6.52**
	(1,150,0.01)	161	8.49	**2.42**	144	-3.94	**-1.88**	12.43	**5.14**
	(1,200,0.01)	149	7.04	**1.84**	126	-5.18	**-2.15**	12.22	**4.41**
Average			6.18			-3.10		9.22	

Table 3: Results on the DJIA 1987-2011

This table reports the results on the DJIA 1987-2011. Trading rules are written as (short, long, band), where short and long represents the short and long moving averages, respectively. A 1% price change is used as the band. N(buy) and N(sell) represents the number of buy/sell trading signals. Buy/Sell represents the mean returns conditional on buy/sell trading signals and the associated t-statistics report the t-test results of the differences of the buy/sell returns from the buy-and-hold returns. The last two columns report βs, which are difference between mean buy and sell returns, and the associated Wald-statistics. β equals the difference of β_1 and β_2, which is estimated by the regression model $R_t = \alpha + \beta_1 D_{t-1}^{Buy} + \beta_2 D_{t-1}^{Sell} + \varepsilon_t$, where R_t represents the returns conditional on buy/sell signals, and D_{t-1}^{Buy} and D_{t-1}^{Sell} are dummy variables that equal 1 when a buy or sell signal is generated and 0 otherwise. The Wald-statistic is Newey-West corrected and marked in bold if it is significant at the 10% level.

Period	Trading Rules	N(Buy)	Buy (*10^{-3})	t-statistics	N(Sell)	Sell (*10^{-3})	t-statistics	β (*10^{-3})	Wald-stats
				VMA Daily					
1987-2011	**(1,50,0)**	3931	0.22	-0.36	2159	0.40	0.31	-0.18	0.27
	(1,150,0)	4108	0.22	-0.37	1882	0.37	0.21	-0.15	0.16
	(5,150,0)	4102	0.20	-0.45	1888	0.41	0.34	-0.21	0.35
	(1,200,0)	4186	0.27	-0.16	1754	0.31	0.02	-0.04	0.01
	(2,200,0)	4184	0.23	-0.30	1756	0.40	0.29	-0.16	0.18
				VMA Band=1% Daily					
1987-2011	**(1,50,0.01)**	3231	0.13	-0.69	1555	0.48	0.52	-0.35	0.63
	(1,150,0.01)	3752	0.24	-0.25	1525	0.46	0.45	-0.22	0.24
	(5,150,0.01)	3742	0.28	-0.12	1518	0.45	0.43	-0.18	0.17
	(1,200,0.01)	3851	0.30	-0.03	1450	0.54	0.69	-0.24	0.30
	(2,200,0.01)	3832	0.28	-0.13	1438	0.51	0.58	-0.23	0.27
Average			0.24			0.43		-0.20	

Period	Trading Rules	N(Buy)	Buy (*10^{-3})	t-statistics	N(Sell)	Sell (*10^{-3})	t-statistics	β (*10^{-3})	Wald-stats
				FMA Holding Period=10 days					
1987-2011	**(1,50,0)**	81	3.01	0.00	111	4.44	0.44	-1.43	0.10
	(1,150,0)	58	-0.12	-0.70	50	-4.93	-1.66	4.81	0.38
	(5,150,0)	48	0.44	-0.53	39	-7.43	**-1.93**	7.87	1.43
	(1,200,0)	48	2.87	-0.03	45	1.43	-0.31	1.44	0.03
	(2,200,0)	40	3.22	0.04	45	3.37	0.07	-0.15	0.00
				FMA Band=1% Holding Period=10 days					
1987-2011	**(1,50,0.01)**	96	-0.69	-1.07	87	7.00	1.09	-7.69	**2.80**
	(1,150,0.01)	45	-2.67	-1.13	52	3.60	0.12	-6.27	0.59
	(5,150,0.01)	37	3.55	0.10	43	1.49	-0.29	2.06	0.10
	(1,200,0.01)	36	-2.66	-1.01	47	9.71	1.35	-12.37	2.06
	(2,200,0.01)	41	-2.64	-1.07	38	9.42	1.17	-12.06	2.59
Average			0.43			2.81		-2.38	

Period	Trading Rules	N(Buy)	Buy (*10^{-3})	t-statistics	N(Sell)	Sell (*10^{-3})	t-statistics	β (*10^{-3})	Wald-stats
				TRB Holding Period=10 days					
1987-2011	**(1,50,0)**	208	-0.48	-1.47	79	5.92	0.76	-6.40	1.03
	(1,150,0)	163	-0.14	-1.18	30	23.49	**3.31**	-23.63	**4.03**
	(1,200,0)	149	0.84	-0.77	21	24.16	**2.87**	-23.32	2.42
				TRB Band=1% Holding Period=10 days					
1987-2011	**(1,50,0.01)**	69	2.81	-0.05	49	2.37	-0.13	0.45	0.00
	(1,150,0.01)	47	0.87	-0.43	20	19.28	**2.15**	-18.41	1.60
	(1,200,0.01)	42	1.37	-0.31	18	27.27	**3.04**	-25.89	**3.05**
Average			0.82			15.04		-14.23	

Table 4: Results for Jensen's α Estimation 1987-2011

This table reports results for the regression model: $r_t^p - r_t^f = \alpha + \beta (r_t^m - r_t^f) + \varepsilon_t$ for the DJIA 1987-2011, where r_t^p represents the returns of technical trading strategies, r_t^f represents the risk free rates which is set as the US 3-month Treasury Bill rate, and r_t^m represents the return on the DJIA index. The excess returns and the systematic risks of the technical trading strategies are captured by α and β, respectively. Trading rules are written as (short, long, band) where short and long represents the short and long moving averages, respectively. A 1% price change is used as the band. The t-statistics are reported in brackets, which are marked in bold if they are significant at the 10% level.

		Buy		Sell		Buy&Sell	
Period	**Trading Rules**	**α (*10^{-4})**	**β**	**α (*10^{-4})**	**β**	**α (*10^{-4})**	**β**
			VMA Daily				
1987-2011	**(1,50,0)**	0.15	0.35	-0.568	-0.65	-0.42	-0.30
		(0.21)	**(10.94)**	(-0.77)	**(-20.44)**	(-0.28)	**(-4.73)**
	(1,150,0)	0.25	0.35	-0.33	-0.65	-0.08	-0.29
		(0.34)	**(10.83)**	(-0.45)	**(-19.84)**	(-0.05)	**(-4.48)**
	(5,150,0)	0.10	0.37	-0.48	-0.63	-0.38	-0.26
		(0.13)	**(10.87)**	(-0.64)	**(-18.53)**	(-0.25)	**(-3.81)**
	(1,200,0)	0.31	0.39	-0.20	-0.61	0.11	-0.23
		(0.43)	**(20.77)**	(-0.28)	**(-32.88)**	(0.08)	**(-6.05)**
	(2,200,0)	0.14	0.39	-0.37	-0.61	-0.23	-0.21
		(0.19)	**(20.83)**	(-0.51)	**(-32.13)**	(-0.16)	**(-5.65)**
			VMA Daily Band=1%				
1987-2011	**(1,50,0.01)**	-0.35	0.28	-0.38	-0.58	-0.73	-0.30
		(-0.51)	**(10.60)**	(-0.50)	**(-15.7)**	(-0.54)	**(-4.84)**
	(1,150,0.01)	0.42	0.32	-0.34	-0.60	0.08	-0.28
		(0.57)	**(10.70)**	(-0.44)	**(-16.66)**	(0.06)	**(-4.25)**
	(5,150,0.01)	0.59	0.33	-0.33	-0.59	0.26	-0.26
		(0.81)	**(10.71)**	(-0.43)	**(-15.87)**	(0.18)	**(-3.85)**
	(1,200,0.01)	0.50	0.35	-0.56	-0.57	-0.06	-0.22
		(0.70)	**(19.98)**	(-0.77)	**(-28.89)**	(-0.05)	**(-6.19)**
	(2,200,0.01)	0.33	0.35	0.00	-0.57	-0.13	-0.21
		(0.47)	**(19.92)**	(-0.63)	**(-28.42)**	(-0.09)	**(-5.82)**
			FMA 10-days				
1987-2011	**(1,50,0)**	0.15	0.01	-0.67	-0.01	-0.52	0.00
		(0.30)	**(3.93)**	(-1.40)	**(-6.07)**	(-0.75)	(0.05)
	(1,150,0)	-0.27	0.01	0.57	-0.02	0.31	-0.01
		(-0.57)	**(2.69)**	(0.83)	(-1.51)	(0.37)	(-0.58)
	(5,150,0)	-0.11	0.00	0.53	-0.01	0.41	0.00
		(-0.40)	**(4.10)**	(1.29)	**(-2.55)**	(0.83)	(-1.02)
	(1,200,0)	-0.04	0.01	-0.37	-0.01	-0.41	0.00
		(-0.09)	**(2.93)**	(-1.01)	**(-2.81)**	(-0.73)	(0.50)
	(2,200,0)	-0.03	0.01	-0.43	0.00	-0.46	0.00
		(-0.06)	**(2.21)**	(-1.51)	**(-4.06)**	(-0.88)	(0.95)
			FMA 10-days Band=1%				
1987-2011	**(1,50,0.01)**	-0.49	0.02	-0.85	-0.01	-1.34	0.00
		(-0.84)	**(3.67)**	**(-1.88)**	**(-5.70)**	**(-1.81)**	(1.06)
	(1,150,0.01)	-0.41	0.01	-0.17	-0.02	-0.57	-0.01
		(-0.96)	**(2.31)**	(-0.24)	(-1.53)	(-0.70)	(-0.73)
	(5,150,0.01)	0.10	0.00	-0.09	-0.01	0.01	0.00
		(0.40)	**(3.21)**	(-0.23)	**(-2.55)**	(0.03)	(-1.09)
	(1,200,0.01)	-0.48	0.01	-0.95	-0.01	-1.43	0.01
		(-0.93)	**(2.64)**	**(-3.08)**	**(-4.54)**	**(-2.37)**	(1.34)
	(2,200,0.01)	-0.41	0.01	-0.76	-0.01	-1.17	0.00
		(-1.05)	**(2.93)**	**(-2.52)**	**(-4.07)**	**(-2.36)**	(0.74)

Period	Trading Rules	Buy		Sell		Buy&Sell	
		α (*10^{-4})	**β**	**α (*10^{-4})**	**β**	**α (*10^{-4})**	**β**
			TRB 10-days				
1987-2011	**(1,50,0)**	-0.70	0.02	-0.45	-0.03	-1.15	-0.02
		(-1.28)	**(7.12)**	(-0.53)	**(-3.26)**	(-1.13)	(-1.68)
	(1,150,0)	-0.41	0.01	-1.06	-0.02	-1.47	-0.01
		(-0.86)	**(6.39)**	**(-1.90)**	**(-3.16)**	**(-1.98)**	(-1.17)
	(1,200,0)	-0.19	0.01	-0.65	-0.02	-0.84	-0.01
		(-0.42)	**(6.01)**	(-1.38)	**(-2.59)**	(-1.29)	(-0.89)
			TRB 10-days Band=1%				
1987-2011	**(1,50,0.01)**	0.09	0.01	0.35	-0.03	0.44	-0.02
		(0.27)	**(4.31)**	(0.40)	**(-2.51)**	(0.47)	(-2.00)
	(1,150,0.01)	-0.09	0.00	-0.37	-0.01	-0.46	-0.01
		(-0.31)	**(3.67)**	(-0.78)	**(-2.66)**	(-0.83)	(-1.81)
	(1,200,0.01)	-0.07	0.00	-0.46	-0.01	-0.54	-0.01
		(-0.28)	**(3.33)**	(-1.04)	**(-2.49)**	(-1.04)	(-1.73)

Table 5: Results on the DJIA 1885-1896

This table reports the results on the DJIA 1885-1896. Trading rules are written as (short, long, band), where short and long represent the short and long moving averages, respectively. A 1% price change is used as the band. N(buy) and N(sell) represents the number of buy/sell trading signals. Buy/Sell represents the mean return conditional on buy/sell trading signals and the associated t-statistics report the t-test results of the difference of the buy/sell returns from the buy-and-hold returns. The last two columns report βs, which is difference between mean buy and sell returns, and the associated Wald-statistics. β equals the difference of β_1 and β_2, which is estimated by the regression model $R_t = \alpha + \beta_1 D_{t-1}^{Buy} + \beta_2 D_{t-1}^{Sell} + \varepsilon_t$, where R_t represents the returns conditional on buy/sell signals, and D_{t-1}^{Buy} and D_{t-1}^{Sell} are dummy variables that equals 1 when a buy or sell signal is generated and 0 otherwise. The Wald-statistic is Newey-West corrected and marked in bold if it is significant at the 10% level.

Period	Trading Rules	N(Buy)	Buy (*10^{-3})	t-statistics	N(Sell)	Sell (*10^{-3})	t-statistics	β (*10^{-3})	Wald-stats
				VMA Daily					
1885-1896	**(1,50,0)**	1787	0.28	1.02	1756	-0.23	-1.10	0.51	**3.45**
	(1,150,0)	1792	0.04	0.03	1651	-0.04	-0.29	0.08	0.07
	(5,150,0)	1776	0.09	0.25	1667	-0.10	-0.52	0.19	0.44
	(1,200,0)	1786	-0.08	-0.44	1607	0.05	0.09	-0.13	0.19
	(2,200,0)	1776	-0.01	-0.17	1617	-0.02	-0.19	0.01	0.00
				VMA Band=1% Daily					
1885-1896	**(1,50,0.01)**	1295	0.47	**1.65**	1241	-0.30	-1.21	0.77	**4.96**
	(1,150,0.01)	1493	0.03	0.02	1278	0.05	0.07	-0.02	0.00
	(5,150,0.01)	1487	0.08	0.20	1258	0.03	0.00	0.05	0.02
	(1,200,0.01)	1505	-0.04	-0.29	1359	0.01	-0.09	-0.05	0.02
	(2,200,0.01)	1501	0.03	0.00	1355	0.02	-0.04	0.01	0.00
Average			0.09			-0.05		0.14	

Period	Trading Rules	Buy	Buy (*10^{-3})	t-statistics	Sell	Sell (*10^{-3})	t-statistics	β (*10^{-3})	Wald-stats
				FMA Holding Period=10 days					
1885-1896	**(1,50,0)**	44	7.24	**1.73**	55	2.85	0.73	4.39	0.74
	(1,150,0)	38	-3.40	-0.82	26	0.72	0.10	-4.11	0.41
	(5,150,0)	25	5.76	1.04	20	-3.84	-0.67	9.61	2.44
	(1,200,0)	25	1.63	0.27	29	4.65	0.89	-3.02	0.31
	(2,200,0)	24	8.16	1.45	24	-0.78	-0.18	8.94	1.98
				FMA Band=1% Holding Period=10 days					
1885-1896	**(1,50,0.01)**	47	3.13	0.75	43	0.85	0.16	2.28	0.17
	(1,150,0.01)	25	9.05	**1.65**	35	-3.44	-0.80	12.49	**4.63**
	(5,150,0.01)	18	8.34	1.29	22	-0.70	-0.15	9.04	**2.79**
	(1,200,0.01)	26	11.41	**2.12**	24	1.39	0.22	10.02	2.40
	(2,200,0.01)	19	16.11	**2.58**	24	-2.30	-0.45	18.42	**5.33**
Average			6.75			-0.06		6.81	

Period	Trading Rules	Buy	Buy (*10^{-3})	t-statistics	Sell	Sell (*10^{-3})	t-statistics	β (*10^{-3})	Wald-stats
				TRB Holding Period=10 days					
1885-1896	**(1,50,0)**	70	7.50	**2.26**	69	-3.20	-1.04	10.70	**5.64**
	(1,150,0)	36	6.46	1.40	36	-3.04	-0.72	9.50	2.28
	(1,200,0)	29	6.53	1.27	31	1.51	0.27	5.02	0.61
				TRB Band=1% Holding Period=10 days					
1885-1896	**(1,50,0.01)**	20	15.07	**2.47**	29	-0.51	-0.14	15.58	**3.18**
	(1,150,0.01)	10	8.71	1.00	19	4.41	0.68	4.30	0.16
	(1,200,0.01)	7	1.81	0.16	18	7.40	1.14	-5.59	0.25
Average			7.55			0.93		6.62	

Table 6: Results for Jensen's α Estimation 1885-1896

This table reports results for the regression model: $r_t^p - r_t^f = \alpha + \beta (r_t^m - r_t^f) + \varepsilon_t$ for the DJIA 1885-1896, where r_t^p represents the returns of technical trading strategies, r_t^f represents the risk free rates which is set as the US 3-month Treasury Bill rate, and r_t^m represents the return on the DJIA index. The excess returns and the systematic risks of the technical trading strategies are captured by α and β, respectively. Trading rules are written as (short, long, band) where short and long represents the short and long moving averages, respectively. A 1% price change is used as the band. The t-statistics are reported in brackets, which are marked in bold if they are significant at the 10% level.

		Buy		Sell		Buy&Sell	
Period	**Trading Rules**	**α (*10^{-4})**	**β**	**α (*10^{-4})**	**β**	**α (*10^{-4})**	**β**
			VMA Daily				
1885-1896	**(1,50,0)**	1.170	0.388	0.146	-0.612	1.315	-0.224
		(1.73)	**(16.5)**	(0.22)	**(-26.00)**	(0.97)	**(-4.75)**
	(1,150,0)	0.015	0.374	-0.945	-0.626	-0.930	-0.252
		(0.02)	**(15.67)**	(-1.39)	**(-26.21)**	(-0.68)	**(-5.27)**
	(5,150,0)	0.300	0.377	-0.669	-0.623	-0.369	-0.246
		(0.44)	**(15.74)**	(-0.98)	**(-26.03)**	(-0.27)	**(-5.14)**
	(1,200,0)	-0.547	0.361	-1.481	-0.639	-2.028	-0.278
		(-0.81)	**(15.12)**	**(-2.18)**	**(-26.75)**	(-1.49)	**(-5.81)**
	(2,200,0)	-0.210	0.361	-1.150	-0.639	-1.360	0.000
		(-0.31)	**(15.13)**	(-1.69)	**(-26.75)**	(-1.00)	**(-5.81)**
			VMA Daily Band=1%				
1885-1896	**(1,50,0.01)**	1.594	0.310	0.246	-0.542	1.840	-0.231
		(2.48)	**(14.36)**	(0.36)	**(-21.39)**	(1.48)	**(-5.07)**
	(1,150,0.01)	0.021	0.328	-1.142	-0.566	-1.121	-0.238
		(0.03)	**(14.41)**	(-1.64)	**(-22.29)**	(-0.87)	**(-5.05)**
	(5,150,0.01)	0.223	0.323	-1.048	-0.552	-0.824	-0.229
		(0.34)	**(14.29)**	(-1.50)	**(-21.39)**	(-0.65)	**(-4.88)**
	(1,200,0.01)	-0.301	0.320	-1.124	-0.595	-1.425	-0.275
		(-0.46)	**(13.95)**	(-1.62)	**(-23.78)**	(-1.10)	**(-5.83)**
	(2,200,0.01)	0.016	0.315	-1.175	-0.589	-1.159	-0.274
		(0.02)	(13.84)	**(-1.69)**	**(-23.38)**	(-0.90)	**(-5.82)**
			FMA 10-days				
1885-1896	**(1,50,0)**	0.878	0.012	-0.721	-0.013	0.157	-0.001
		(1.69)	**(3.14)**	(-1.36)	**(-3.19)**	(0.21)	(-0.10)
	(1,150,0)	-0.360	0.012	-0.204	-0.006	-0.563	0.006
		(-0.73)	**(2.85)**	(-0.57)	**(-2.95)**	(-0.92)	(1.32)
	(5,150,0)	0.415	0.007	0.135	-0.002	0.550	0.004
		(1.08)	**(3.03)**	(0.63)	**(-2.72)**	(1.25)	**(1.89)**
	(1,200,0)	0.105	0.005	-0.550	-0.005	-0.445	0.000
		(0.33)	**(2.65)**	**(-1.71)**	**(-3.01)**	(-0.98)	(-0.05)
	(2,200,0)	0.607	0.008	-0.048	-0.002	0.559	0.005
		(1.38)	**(2.08)**	(-0.22)	**(-2.61)**	(1.13)	(1.40)
			FMA 10-days Band=1%				
1885-1896	**(1,50,0.01)**	0.42	0.016	-0.312	-0.009	0.103	0.007
		(0.71)	**(3.72)**	(-0.71)	**(-3.59)**	(0.14)	(1.37)
	(1,150,0.01)	0.635	0.005	0.155	-0.008	0.790	-0.003
		(1.83)	**(2.64)**	(0.41)	**(-1.96)**	(1.53)	(-0.57)
	(5,150,0.01)	0.416	0.003	-0.036	-0.001	0.380	0.002
		(1.51)	**(2.09)**	(-0.21)	**(-2.90)**	(1.17)	(1.17)
	(1,200,0.01)	0.931	0.011	-0.195	-0.002	0.736	0.008
		(1.75)	**(1.66)**	(-0.89)	**(-3.33)**	(1.27)	(1.29)
	(2,200,0.01)	0.969	0.010	0.050	-0.003	1.019	0.006
		(1.88)	(1.51)	(0.20)	**(-2.90)**	**(1.77)**	(0.98)

		Buy		Sell		Buy&Sell	
Period	**Trading Rules**	**α (*10^{-4})**	**β**	**α (*10^{-4})**	**β**	**α (*10^{-4})**	**β**
			TRB 10-days				
1885-1896	**(1,50,0)**	1.418	0.017	0.237	-0.023	1.655	-0.005
		(2.29)	**(2.87)**	(0.36)	**(-3.86)**	**(1.82)**	(-0.64)
	(1,150,0)	0.626	0.006	0.042	-0.016	0.668	-0.010
		(1.79)	**(3.26)**	(0.08)	**(-3.41)**	(1.04)	**(-2.07)**
	(1,200,0)	0.515	0.004	-0.392	-0.013	0.124	-0.009
		(1.78)	**(3.49)**	(-0.80)	**(-3.16)**	(0.22)	**(-2.10)**
			TRB 10-days Band=1%				
1885-1896	**(1,50,0.01)**	0.86	0.007	-0.153	-0.013	0.707	-0.006
		(2.11)	**(2.32)**	(-0.31)	**(-3.52)**	(1.09)	(-1.15)
	(1,150,0.01)	0.244	0.002	-0.433	-0.012	-0.189	-0.010
		(1.25)	**(2.37)**	(-0.87)	**(-3.17)**	(-0.36)	**(-2.65)**
	(1,200,0.01)	0.029	0.001	-0.598	-0.012	-0.569	-0.011
		(0.20)	**(1.88)**	(-1.24)	**(-3.06)**	(-1.13)	**(-2.79)**

Figure 1: Cumulative Wealth of the Variable-Length Moving Average Rule (1, 50) on the DJIA 1987 - 1991

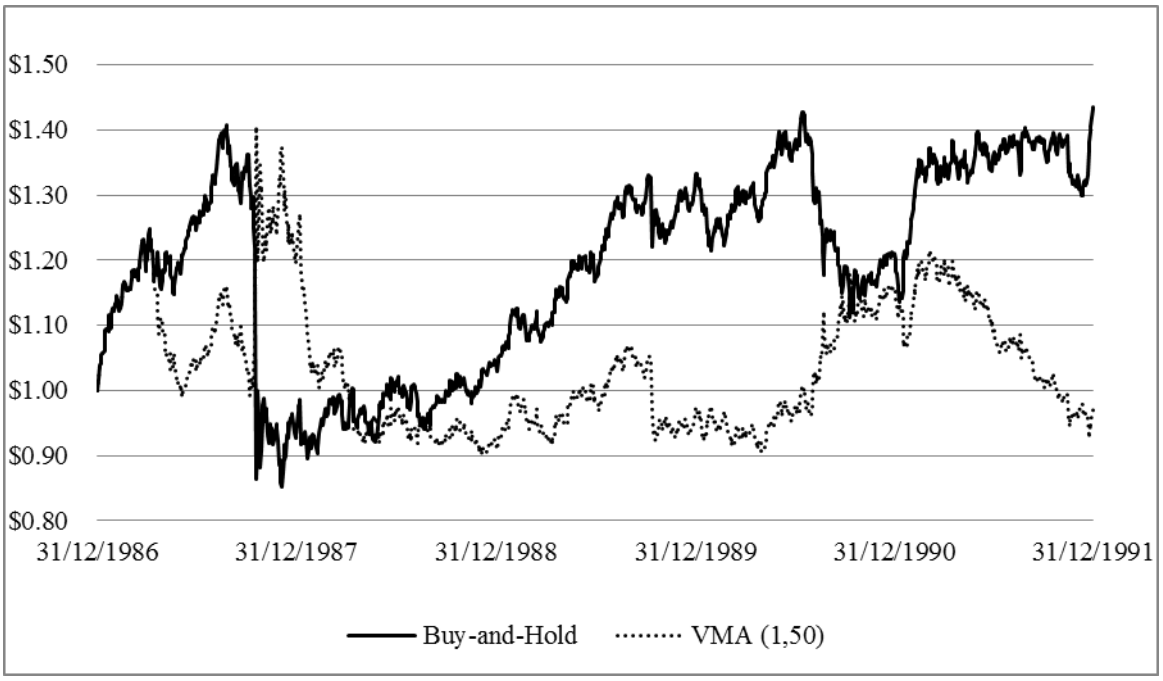

Figure 2: Cumulative Wealth of the Variable-Length Moving Average Rule (1, 50) on the DJIA 1987 – 1995

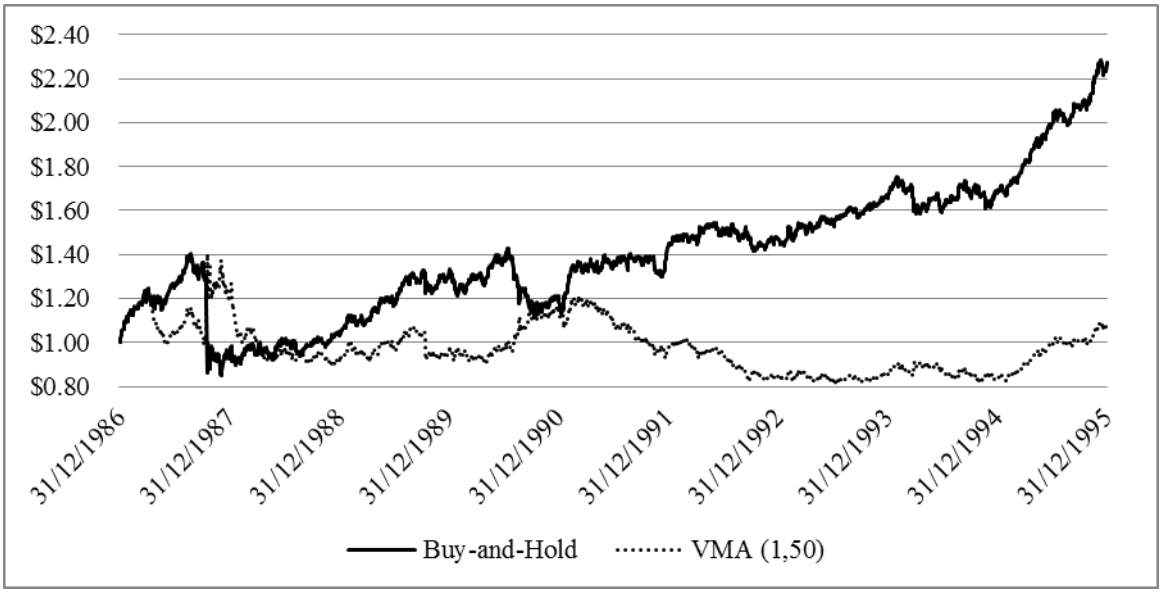

Figure 3: Cumulative Wealth of the Variable-Length Moving Average Rule (1, 50) on the DJIA 1987 – 2011